Description

FLAME RETARDANT POLYESTER FIBER FOR ARTIFICIAL HAIR

5   Technical Field

The present invention relates to a flame retardant polyester fiber for artificial hair, made of a polyester and a brominated epoxy flame retardant. More particularly, the present invention relates to a fiber

10   for artificial hair which maintains fiber properties such as flame resistance, heat resistance, and strength and elongation, and has excellent curl-setting properties, transparence, devitrification resistance, and combing properties.

15   The present invention also relates to a modified cross-section fiber. More particularly, the present invention relates to a modified cross-section fiber having luster, hue, texture and bulkiness close to human hair, which is used as a fiber for artificial hair for

20   hair goods or the like such as wig, braid, or extension hair, and to a fiber for artificial hair using the modified cross-section fiber.

Furthermore, the present invention relates to a fiber for artificial hair which has excellent smooth

25   feeling, combing properties, and antistatic properties.

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Background Art

Fibers made of polyethylene terephthalate or a polyester comprising polyethylene terephthalate as a main component has excellent heat resistance, chemical

5 resistance, a high melting point and a high modulus of elasticity, therefore are thus widely used in curtains, carpets, clothes, blankets, sheetings, table clothes, upholstery fabrics, wall coverings, artificial hair, interior materials for automobiles, outdoor reinforcing

10 materials, and safety nets.

On the other hand, human hair, artificial hair (modacrylic fibers, polyvinyl chloride fibers), or the like has been conventionally used in hair products such as wigs, hair wigs, extensions, hair bands, and doll hair.

15 However, it has now become difficult to provide human hair for hair products, and thus artificial hair has become more important. Modacrylic fibers have been often used as artificial hair materials due to their flame retardance, but have only insufficient heat resistance.

20 In recent years, there has been proposed artificial hair using, as a main component, a polyester typified by polyethylene terephthalate having excellent heat resistance. However, fibers made of a polyester typified by polyethylene terephthalate are flammable materials,

25 and thus have insufficient flame resistance.

Conventionally, various attempts have been made to improve flame resistance of polyester fibers. Known

examples of such attempts include a method comprising using a fiber made of a polyester obtained by copolymerizing a flame retardant monomer containing a phosphorus atom, and a method comprising adding a flame

5   retardant to a polyester fiber.

As the former method comprising copolymerizing a flame retardant monomer, a method comprising copolymerizing a phosphorus compound with excellent heat stability having a phosphorus atom as a ring member

10   (Japanese Patent Publication No. 55-41610), a method comprising copolymerizing carboxyphosphinic acid (Japanese Patent Publication No. 53-13479), a method comprising copolymerizing a polyester containing a polyallylate with a phosphorus compound (Japanese Patent

15   Laid-open No. 11-124732), or the like has been proposed.

As artificial hair to which the above flame retardant technology is applied, a polyester fiber copolymerized with a phosphorus compound has been proposed (Japanese Patent Laid-open No. 03-27105,

20   Japanese Patent Laid-open No. 05-339805, etc.), for example.

However, since artificial hair is demanded to be highly flame resistant, such a copolymer polyester fiber must have a high copolymerization amount when used for

25   artificial hair. This results in a significant decrease in flame resistance of the polyester, and causes other problems in which it is difficult to perform melt

spinning, or, when flame approaches, the artificial hair does not catch fire and is not burned, but molten and dripped. When the phosphorus flame retardant is added, stickiness is increased because it must be added in a

5   large amount to exhibit flame retardance, and the resulting artificial hair made of a polyester fiber tends to have a heat history and, under high humidity conditions, be devitrified to affect the appearance of the fiber.

10   On the other hand, as the latter method comprising adding a flame retardant, a method comprising adding a halogenated cycloalkane compound as fine particles to a polyester fiber (Japanese Patent Publication No. 03-57990), a method comprising adding a bromine-containing

15   alkylcyclohexane to a polyester fiber (Japanese Patent Publication No. 01-24913), or the like has been proposed. However, in the method comprising adding a flame retardant to a polyester fiber, in order to achieve sufficient flame retardance, the addition treatment

20   temperature must be as high as 150°C or more, the addition treatment time must be long, or a large amount of a flame retardant must be used, disadvantageously. This causes problems such as deteriorated fiber properties, reduced productivity, and an increased

25   production cost.

        As described above, artificial hair has not yet been provided which maintains fiber properties possessed by a

conventional polyester fiber such as flame resistance, heat resistance, and strength and elongation and has excellent setting properties, devitrification resistance, and stickiness reduction.

5   Synthetic fibers conventionally used for hair include acrylonitrile fibers, vinyl chloride fibers, vinylidene chloride fibers, polyester fibers, nylon fibers, and polyolefin fibers. Conventionally, these fibers have been processed into products for artificial

10   hair such as wigs, braids, and extension hair. However, these fibers do not have properties necessary for a fiber for artificial hair such as heat resistance, curling properties, and good feeling together. Thus, products with various properties satisfied cannot be produced from

15   a single fiber, and products making use of properties of each fiber are produced and used. Fibers having a cross-section suitable to characteristics of each goods have also been studied and improved.

       Examples of such fibers include a filament for wigs

20   having a cocoon cross-section with a length L of a longest part, a diameter W of round parts on both ends, and a width C of a central constriction, each within a specific range (Japanese Utility Model Laid-open No. 48-13277); a synthetic fiber for artificial hair having a

25   largest diameter (L) passing through the gravity in the fiber cross-section within a specific range (Japanese Patent Publication No. 53-6253); a filament for wigs and

braids having a Y-shaped cross-section in which four unit filaments having an almost round shape or an elliptical shape are provided with one unit filament radially adjacent to the other three unit filaments at the same

5   intervals, and the adjacent unit filaments have contact points having a width almost equal to the radius of the unit filaments (Japanese Utility Model Laid-open No. 63-78026); and a filament for wigs having a cross-section with at least two flat circles lapped, in which the ratio

10   L/W of the major axis length L to the minor axis length W, the distance between the centers of two adjacent flat circles, the angle between the straight line linking the centers of two adjacent flat circles and the major axes of the flat circles, and the like are limited (Japanese

15   Patent Laid-open No. 55-51802).

However, any of the above-described conventional fibers developed as fibers for artificial hair has a cross-section with a length and an angle extremely limited and with a unique shape, and cannot necessarily

20   easily produced. In addition, such fibers do not necessarily have preferable texture when used for braids or extension hair, and tend to be felt hard because the fibers are intended to keep a hairstyle or make the resulting hair straight. Further, these fibers cannot be

25   sufficiently easily handled manually. Ribbon-section fibers have conventionally widely used for piles, but have been assumed to be inappropriate for use as fibers

for artificial hair such as wigs due to their disliked too much softness or the like.

On the other hand, in the method comprising adding a flame retardant to a polyester fiber, in order to achieve

5   sufficient flame retardance, the addition treatment temperature must be as high as 150°C or higher, the addition treatment time must be long, or a large amount of a flame retardant must be used, disadvantageously. This causes problems such as deteriorated fiber

10   properties, decreased productivity, and an increased production cost.

In order to provide such synthetic fibers poorly flame retardant or not flame retardant with flexibility, smooth feeling, or the like, various silicone finishing

15   agents have been provided. Examples of the finishing agents for providing the fibers with flexibility, crease resistance, elastic force, and compression recovery properties include dimethylpolysiloxane, methylhydrogenpolysiloxane, dimethylpolysiloxane having

20   hydroxyl groups at both terminals, a vinyl group-containing organopolysiloxane, an epoxy group-containing organopolysiloxane, an amino group-containing organopolysiloxane, an ester group-containing organopolysiloxane, and a polyoxyalkylene-containing

25   organopolysiloxane. A treating agent composed of a combination of alkoxysilanes and/or a polyacrylamide resin or a catalyst or the like has also been known.

For example, there is disclosed a method using a treating agent composed of an organopolysiloxane containing at least two epoxy groups in one molecule and an organopolysiloxane containing an amino group, or a

5   treating agent composed of an organopolysiloxane having hydroxyl groups at both terminals, and an organopolysiloxane containing an amino group and an alkoxy group in one molecule and/or its partial hydrolysate and condensate (Japanese Patent Publication

10   No. 53-36079).

Further, there are described a treating agent composed of an organopolysiloxane containing an epoxy group and an aminoalkyltrialkoxysilane (Japanese Patent Publication No. 53-197159 and Japanese Patent Publication

15   No. 53-19716), and a diorganopolysiloxane having triorganosiloxy groups at both terminals, which contains two or more amino groups in one molecule (Japanese Patent Publication No. 53-98499). In addition, there is proposed a method using a treating agent composed of an

20   aminopolysiloxane containing two or more amino groups in one molecule and an alkoxysilane containing one or more reactive groups such as amino groups or epoxy groups (Japanese Patent Publication No. 58-17310).

Further, there are disclosed a method using a

25   treating agent composed of a diorganosiloxane containing at least two amino groups in one molecule and a diorganopolysiloxane containing at least two ester bonds

in one molecule (Japanese Patent Laid-open No. 55-152864), and a method using a polysiloxane containing an amino group, a hydroxyl group-terminated polysiloxane, and an alkylalkoxysilane containing a reactive group (Japanese

5   Patent Laid-open No. 58-214585). In addition, there are disclosed a method using a treating agent composed of an organopolysiloxane containing an epoxy group, an aminosilane compound, and a curing catalyst (Japanese Patent Laid-open No. 59-144683), and a method using an

10   organopolysiloxane containing at least two epoxy groups in one molecule and a polyacrylamide resin (Japanese Patent Laid-open No. 60-94680).

However, fibers to which these silicone-containing fiber treating agents are attached exhibit improved

15   smooth feeling, combing properties, and the like, but the silicone-containing fiber treating agents are flammable, and thus provide significantly reduce flame retardance of flame retardant synthetic fibers, disadvantageously.

20

Disclosure of the Invention

The present invention relates to a flame retardant polyester fiber for artificial hair, formed from 100 parts by weight of (A) a polyester made of one or more of

25   polyalkylene terephthalate and a copolymer polyester comprising polyalkylene terephthalate as a main component,

and 5 to 30 parts by weight of (B) a brominated epoxy flame retardant represented by the general formula (1):

(1)
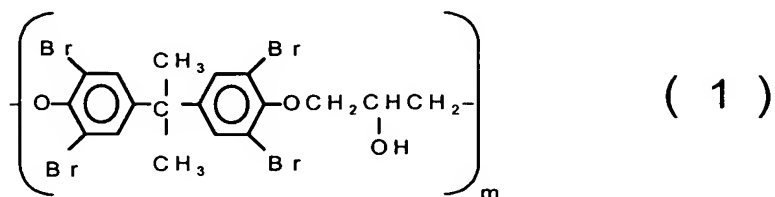
5 and more preferably the flame retardant polyester fiber for artificial hair, wherein the component (A) is a polyester made of at least one polymer selected from the group consisting of polyethylene terephthalate, polypropylene terephthalate, and polybutylene

10 terephthalate, or the flame retardant polyester fiber for artificial hair, wherein the component (B) is at least one flame retardant selected from the group consisting of brominated epoxy flame retardants represented by the general formulas (α) to (γ):

15

(α)
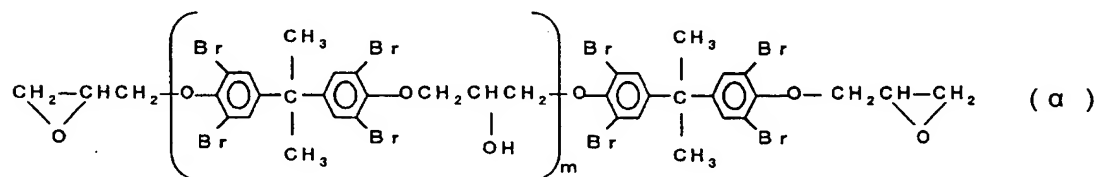
wherein m represents 0 to 150,

(β)
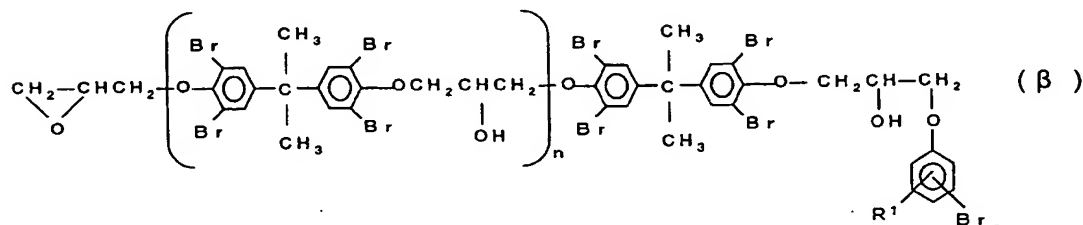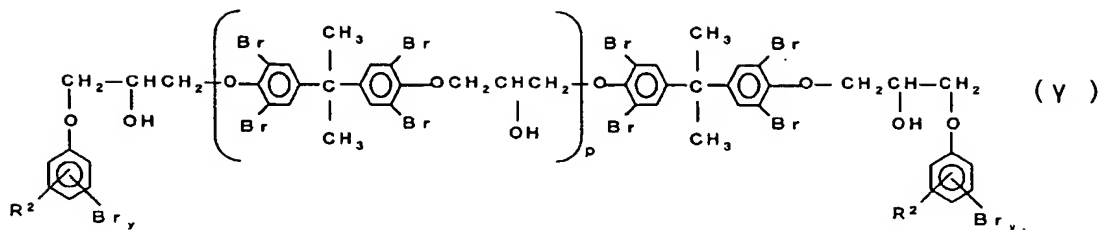
wherein p represents 0 to 150, and y represents 0 to 5.

Preferably, the present invention relates to the
flame retardant polyester fiber for artificial hair,
characterized by comprising the components (A) and (B)
further mixed with (C) organic fine particles and/or (D)
inorganic fine particles to form minute projections on
the fiber surface, wherein the component (C) is at least
one member selected from the group consisting of a
polyallylate, polyamide, fluororesin, silicone resin,
crosslinked acrylic resin, and crosslinked polystyrene,
or wherein the component (D) is at least one member
selected from the group consisting of calcium carbonate,
silicon oxide, titanium oxide, aluminum oxide, zinc oxide,
talc, kaolin, montmorillonite, bentonite, mica, and an
antimony compound.

The present invention also relates to a fiber for
artificial hair, comprising the flame retardant polyester
fiber to which (E) a hydrophilic fiber treating agent
comprising an aliphatic polyether compound as a main
component is attached. A flame retardant fiber for
artificial hair is thus provided which does not have

reduced flame retardance as in the case where a flame retardant polyester fiber, a flame retardant polypropylene fiber, a flame retardant polyamide fiber, or the like is treated with a silicone fiber treating

5   agent in order to improve smooth feeling and texture, for example; has slip feeling, combing properties, and antistatic properties the same as in the case where such a fiber is treated with a silicone oil agent for the same purpose; and has excellent flame retardance.

10   Further, the polyester fiber of the present invention can have a specific modified cross-section. The present invention further relates to the polyester fiber for artificial hair, which has at least one modified cross-section selected from the group consisting

15   of shapes of an ellipse, crossed circles, a cocoon, a potbelly, a dog bone, a ribbon, three to eight leaves, and a star. The present invention also relates to the polyester fiber for artificial hair, wherein the fiber cross-section has a shape with two or more circles or

20   flat circles lapped or brought into contact with each other. The present invention also relates to the polyester fiber for artificial hair, wherein the fiber cross-section has a shape of three to eight leaves, and the fiber is a modified cross-section fiber having a

25   degree of modification represented by the expression (1) of 1.1 to 8. The present invention further relates to the polyester fiber for artificial hair, wherein the

fiber cross-section has a flatness ratio of 1.2 to 4. The present invention still further relates to the polyester fiber for artificial hair, which is a mixture of a fiber having a round cross-section with a fiber

5   having at least one modified cross-section selected from the group consisting of shapes of an ellipse, crossed circles, a cocoon, a potbelly, a dog bone, a ribbon, three to eight leaves, and a star, wherein the mixing ratio of the fiber having a round cross-section to the

10   fiber having a modified cross-section is 8:2 to 1:9.

        Preferably, the flame retardant polyester fiber for artificial hair is in the form of a non-crimped fiber, is spun dyed, and has a monofilament size of 30 to 80 dtex.

Brief Description of the Drawings

15   Figures 1 to 10 are schematic views respectively showing a cross-section of a polyester fiber made of the composition of the present invention, with the figures corresponding to the following:

        Figure 1: A view of a cross-section in the shape of

20   crossed circles

        Figure 2: A view of a cross-section in the shape of crossed flat circles

        Figure 3: A view of a cross-section in the shape of a dog bone

25   Figure 4: A view of a cross-section in the shape of three leaves

Figure 5: A view of a cross-section in the shape of five leaves

Figure 6: A view of a cross-section in the shape of seven leaves

5   Figure 7: A view for describing a flatness ratio of a modified cross-section

Figure 8: A modified nozzle 1

Figure 9: A modified nozzle 2

Figure 10: A modified nozzle 3

10

Best Mode for Carrying Out the Invention

The flame retardant polyester fiber for artificial hair of the present invention is a fiber obtained by melt spinning a composition comprising (A) a polyester made of

15   one or more of polyalkylene terephthalate or a copolymer polyester comprising polyalkylene terephthalate as a main component, and (B) a brominated epoxy flame retardant. Examples of the polyalkylene terephthalate or the copolymer polyester comprising polyalkylene terephthalate

20   as a main component, which is contained in the polyester (A) used in the present invention, include polyalkylene terephthalates such as polyethylene terephthalate, polypropylene terephthalate, and polybutylene terephthalate, and/or a copolymer polyester comprising

25   such polyalkylene terephthalate as a main component and a small amount of a copolymerization component. The phrase

"containing as a main component" refers to "containing in an amount of 80 mol% or more".

Examples of the copolymerization component include polycarboxylic acids such as isophthalic acid,
5   orthophthalic acid, naphthalenedicarboxylic acid, paraphenylenedicarboxylic acid, trimellitic acid, pyromellitic acid, succinic acid, glutaric acid, adipic acid, suberic acid, azelaic acid, sebacic acid, and dodecanedioic acid, and their derivatives; 5-
10 sodiumsulfoisophthalic acid; dicarboxylic acids including sulfonic acid salts such as dihydroxyethyl 5-sodiumsulfoisophthalate, and their derivatives; 1,2-propanediol, 1,3-propanediol, 1,4-butanediol, 1,6-hexanediol, neopentyl glycol, 1,4-cyclohexanedimethanol,
15 diethylene glycol, polyethylene glycol, trimethylolpropane, pentaerythritol, 4-hydroxybenzoic acid, and ε-caprolactone.

Typically, the copolymer polyester is preferably produced by adding a small amount of a copolymerization
20 component to a main component which is a polymer of terephthalic acid and/or its derivative (for example, methyl terephthalate) and alkylene glycol, and reacting these components, in view of stability and convenience for handling. However, the copolymer polyester may be
25 produced by adding a small amount of a monomer or oligomer component as a copolymerization component to a main component which is a mixture of terephthalic acid

and/or its derivative (for example, methyl terephthalate) and alkylene glycol, and polymerizing the components.

The copolymer polyester may be any copolymer polyester in which the copolymerization component is
5   polycondensed with the main chain and/or the side chain of polyalkylene terephthalate as a main component. There are no particular limitations to the manner of polymerization and the like.

Examples of the copolymer polyester comprising
10 polyalkylene terephthalate as a main component include a polyester obtained by copolymerizing polyethylene terephthalate as a main component with ethylene glycol ether of bisphenol A; a polyester obtained by copolymerizing polyethylene terephthalate as a main
15 component with 1,4-cyclohexanedimethanol; and a polyester obtained by copolymerizing polyethylene terephthalate as a main component with dihydroxyethyl 5-sodiumsulfoisophthalate
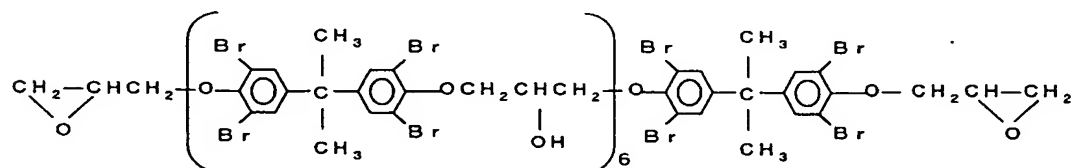
The polyalkylene terephthate and its copolymer
20 polyester may be used singly or in a combination of two or more. Preferable examples thereof include polyethylene terephthalate, polypropylene terephthalate, polybutylene terephthalate, and a copolymer polyester (a polyester obtained by copolymerizing polyethylene
25 terephthalate as a main component with ethylene glycol ether of bisphenol A; a polyester obtained by copolymerizing polyethylene terephthalate as a main
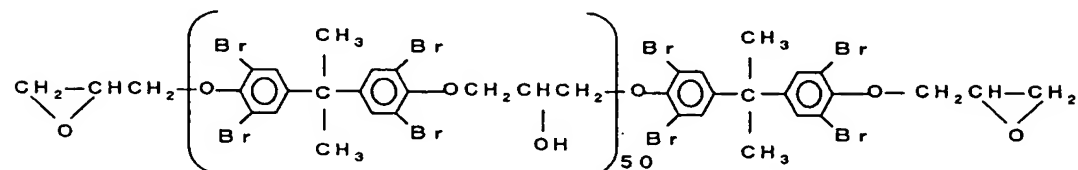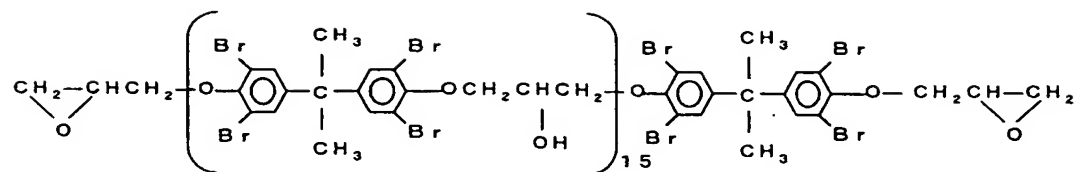
component with 1,4-cyclohexanedimethanol; a polyester

obtained by copolymerizing polyethylene terephthalate as

a main component with dihydroxyethyl 5-

sodiumsulfoisophthalate; or the like). A mixture of two

5   or more of these is also preferable.

The component (A) has an intrinsic viscosity of

preferably 0.5 to 1.4, and more preferably 0.5 to 1.0.

If the intrinsic viscosity is less than 0.5, the

resulting fiber tends to have reduced mechanical strength.

10   If more than 1.4, the melt viscosity is increased as the

molecular weight is increased, and thus the fiber tends

to be melt spinned only with difficulty, and have a non-
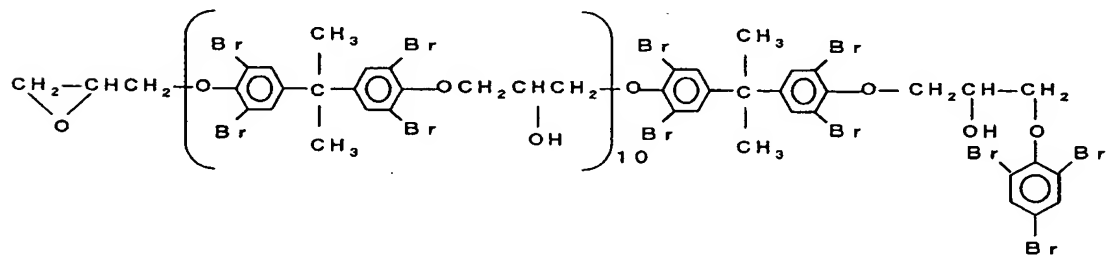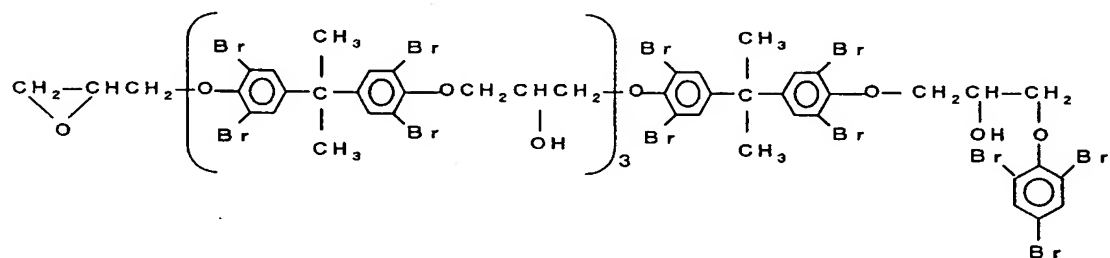
uniform size.

There are no specific limitations to the brominated

15   epoxy flame retardant (B) used in the present invention.

A conventional brominated epoxy flame retardant may be

used.

Specific examples of the component (B) include a

terminal non-blocked brominated epoxy flame retardant

20   with, containing a compound represented by the following

formula (α):

$$CH_2-CHCH_2-O-\left[\text{Br}\,\text{C}(CH_3)_2\,\text{Br}-OCH_2CHCH_2\atop OH\right]_{15}O-\text{Br}\,\text{C}(CH_3)_2\,\text{Br}-O-CH_2CH-CH_2$$

$$CH_2-CHCH_2-\left[O-\text{Br}\,\text{C}(CH_3)_2\,\text{Br}-OCH_2CHCH_2\atop OH\right]_{50}O-\text{Br}\,\text{C}(CH_3)_2\,\text{Br}-O-CH_2CH-CH_2$$

5   a brominated epoxy flame retardant with one terminal blocked, containing a compound represented by the following formula (β):

$$CH_2-CHCH_2-\left[O-\text{Br}\,\text{C}(CH_3)_2\,\text{Br}-OCH_2CHCH_2\atop OH\right]_{3}O-\text{Br}\,\text{C}(CH_3)_2\,\text{Br}-O-CH_2CH-CH_2$$

$$CH_2-CHCH_2-\left[O-\text{Br}\,\text{C}(CH_3)_2\,\text{Br}-OCH_2CHCH_2\atop OH\right]_{10}O-\text{Br}\,\text{C}(CH_3)_2\,\text{Br}-O-CH_2CH-CH_2$$

, and
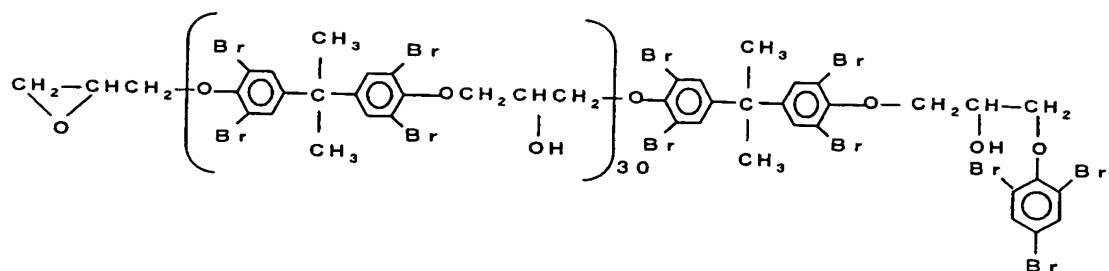
a brominated epoxy flame retardant with both terminals

5   blocked, containing a compound represented by the

following formula (γ):

10

These may be used singly or in a combination of two or more.

The component (B) is used in an amount of 5 to 30 parts by weight based on 100 parts by weight of the

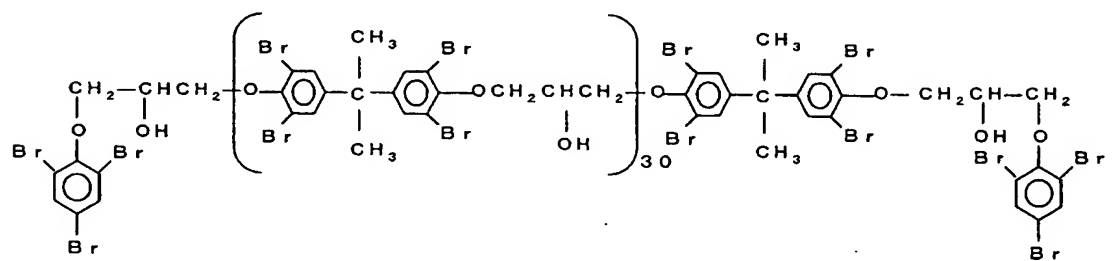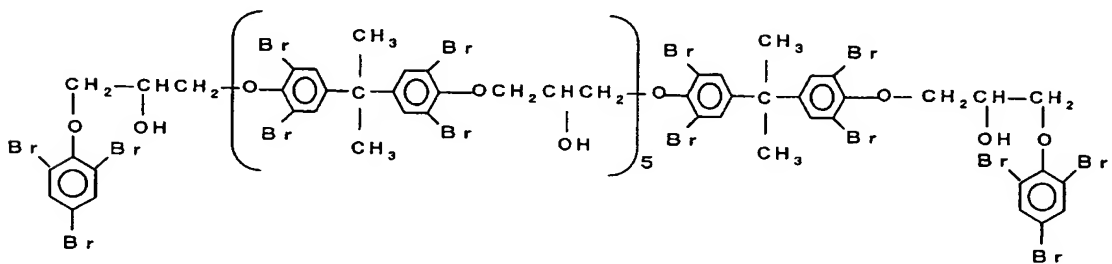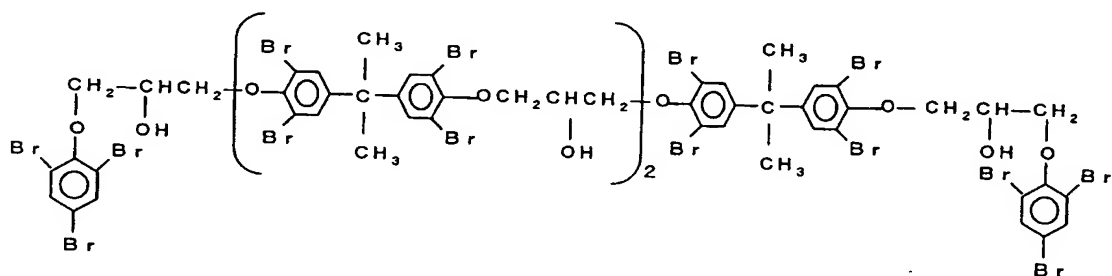5   component (A). In particularly, the amount is preferably 6 to 25 parts by weight, and more preferably 8 to 20 parts by weight. If the component (B) is used in an amount of less than 5 parts by weight, it is difficult to achieve a flame retardant effect. If more than 30 parts

10 by weight, mechanical properties, heat resistance, and drip resistance are impaired.

The component (B) has a number average molecular weight of preferably 20,000 or more, and more preferably 30,000 to 80,000. If the number average molecular weight

15 is less than 20,000, a domain in which the flame retardant is dispersed in the polyester is small, projections on the fiber surface are large, and the fiber is highly glossy. If the molecular weight is too high, the dispersion domain is large, and the fiber is less

20 colored.

As the component (C), any organic resin component may be used insofar as the component is not compatible or partially not compatible with the component (A) as a main component and/or the component (B). For example, a

25 polyallylate, polyamide, fluororesin, silicone resin, crosslinked acrylic resin, crosslinked polystyrene, and

the like are preferably used. These may be used singly or in a combination of two or more.

As the component (D), such a component having a refractive index close to those of the component (A) and/or the component (B) is preferable. This is because the component has an influence on transparence and coloration of the fiber. Examples include calcium carbonate, silicon oxide, titanium oxide, aluminum oxide, zinc oxide, talc, kaolin, montmorillonite, bentonite, mica, and an antimony compound. There are no specific limitations to an antimony compound among these used as the component (D). Specific examples include an antimony trioxide compound, an antimony pentoxide compound, and sodium antimonite. Such an antimony compound has a particle size of preferably 0.02 to 5 μm, more preferably 0.02 to 3 μm, and still more preferably 0.02 to 2 μm, but the particle size is not specifically limited thereto. The antimony compound used in the present invention may be surface treated with an epoxy compound, silane compound, isocyanate compound, titanate compound, or the like as required.

The antimony compound is used in an amount of preferably 0.1 to 5 parts by weight, more preferably 0.1 to 3 parts by weight, and still more preferably 0.2 to 2 parts by weight based on 100 parts by weight of the component (A), but the amount is not specifically limited thereto. If the compound is used in an amount of more

than 5 parts by weight, the fiber has impaired appearance, hue, and coloration. If less than 0.1 part by weight, only a small number of minute projections are formed on the fiber surface, and thus gloss on the fiber surface is

5   inadequately adjusted. The component (D) may be used in combination with another component (D). In this case, the components (D) are used in a total amount of 5 parts by weight.

The antimony compound is preferably used as the
10   component (D), since the compound can not only control properties of the fiber surface, but also improve the flame retardant effect of the fiber itself.

There are no specific limitations to the hydrophilic fiber treating agent (E) used in the present invention.
15   The fiber treating agent may be a mixture of at least one member selected from the group consisting of polyoxyalkylene alkyl ether, polyoxyalkylene alkenyl ether, polyoxyalkylene aryl ethers, and polyoxyalkylene alkylaryl ether, and their random copolymer polyethers,
20   polyoxyalkylene alkyl ester, polyoxyalkylene alkenyl ester, and polyoxyalkylene alkylaryl ester with a conventionally used ether-containing fiber treating agent such as a polyoxyalkylene alkylamine, N,N-dihydroxyethylalkylamide, polyoxyalkylene alkylamide,
25   glycerol fatty acid ester, polyglycerol fatty acid ester, pentaerythritol fatty acid ester, polyoxyalkylene pentaerythritol alkyl ester, sorbitan fatty acid ester,

polyoxyalkylene sorbitan fatty acid ester, sucrose fatty
acid ester, polyoxyalkylene sucrose fatty acid ester,
polyoxyalkylene, alkylamine salt, alkylammonium salt,
alkylaralkylammonium salt, alkylpyridinium salt,

5   alkylpicolinium salt, fatty acid salt, resinate, sulfated
fatty acid salt, alkyl sulfonate, alkylbenzene sulfonate,
alkylnaphthalene sulfonate, sulfofatty acid alkyl ester
salt, dialkyl sulfosuccinate, polyoxyalkylene alkyl ether
monosulfosuccinate, polyoxyalkylene alkenyl ether

10   monosulfosuccinate, polyoxyalkylene aryl ether
monosulfosuccinate, alkyl diphenyl ether disulfonate,
sulfated oil, sulfated fatty acid ester salt, alkyl
sulfate, alkenyl sulfate, polyoxyalkylene alkyl ether
sulfate, polyoxyalkylene alkyl ether carboxylate,

15   polyoxyalkylene alkenyl ether sulfate, polyoxyalkylene
aryl ether sulfate, alkyl phosphate, polyoxyalkylene
alkyl ether phosphate, polyoxyalkylene alkenyl ether
phosphate, or polyoxyalkylene aryl ether phosphate; or a
mixture of a conventionally used ether-containing fiber

20   treating agent with a conventionally used ionic
surfactant. However, the fiber treating agent must not
contain a compound containing a silicone component,
because the treating agent has significantly reduced
flame retardance if it contains a constituent having a

25   silicone component as a main component. The hydrophilic
fiber treating agent (E) is preferably at least one
member selected from the group consisting of a polyether

compound, fatty acid ester compound, organic amine,
organic amide, organic fatty acid ester, organic amine
salt, organic ammonium salt, organic pyridium salt,
organic ammonium salt, organic pyridinium salt, organic
picolinium salt, organic fatty acid salt, resinate,
organic sulfonate, organic succinate, organic
monosuccinate, organic carboxylate, and organic sulfate,
or a mixture of two or more thereof, and particularly
preferably at least one member selected from the group
consisting of a polyethylene oxide-polypropylene oxide
random copolymer polyether (molecular weight MW: 15,000
to 50,000), polyethylene oxide (molecular weight: 100 to
1,000), and polypropylene oxide (molecular weight: 100 to
1,000). The hydrophilic fiber treating agent (E) is
attached to the fiber preferably at a total weight ratio
of 0.01% to 1%, in order to provide smooth feeling,
combing properties, antistatic properties, and the like.
If the hydrophilic fiber treating agent (E) is added in
an amount of 0.01% or less, the fiber has insufficient
combing properties and smooth feeling. On the other hand,
if 1% or more, an oil agent is attached to hands and
makes the hands wet when touching a tow filament, and the
flame retardance of the fiber may be reduced since the
oil agent itself is more or less flammable, unfavorably.
In order to make the fiber exhibit excellent smooth
feeling and combing properties and sufficient antistatic
properties, a 50:50 combination of an ethylene oxide-

propylene oxide random copolymer polyether with a
cationic surfactant is most preferable. However, the
present invention is not limited thereto. The fiber
treating agent may be attached to the fiber by treatment
5   continuous from drawing or heat treatment or by batch
treatment.

The polyester fiber can have a specific modified
cross-section.

When the fiber of the present invention has a cross-
10   section in which two or more circles or flat circles are
lapped or brought into contact with each other (as shown
in Figures 1 to 3, wherein the ratio of the major axis a
to the minor axis b (a/b) is 1.2 to 4), the two or more
circles or flat circles lapped or brought into contact
15   with each other are preferably arranged on a straight
line and bilaterally symmetric.

When the fiber of the present invention has a cross-
section with a shape of three to eight leaves (of which
examples are shown in Figures 4 to 6, wherein the ratio
20   of the circumscribed circle diameter D to the inscribed
circle diameter d (D/d) is 1.1 to 8), the fiber has a
degree of modification represented by the expression (1)
of preferably 1.1 to 8, and more preferably 1.3 to 6. If
the degree of modification exceeds 8, the fiber tends to
25   exhibits impaired feeling and combing properties. If
less than 1.1, the fiber tends to be felt hard. If the
cross-section has a shape of nine or more leaves, its

difference from a round cross-section tends to be small, and the effect of the present invention tends to be decreased.

(Expression 1)

5   Degree of modification = (Circumscribed circle diameter of monofilament cross-section)/(Inscribed circle diameter of monofilament cross-section)

In the present invention, the modified cross-section has a flatness ratio (ratio of the major axis length to 10   the minor axis length in the cross-section) of preferably 1.2 to 4, and more preferably 1.5 to 2.5, as shown in Figure 7, wherein the ratio of the major axis x to the minor axis y (x/y) is 1.2 to 4. If the flatness ratio exceeds 4, the fiber cannot be provided with luster and 15   feeling close to human hair. If less than 1.2, the fiber tends to have a hard texture.

When the polyester fiber of the present invention used is a mixture of a fiber having a round cross-section with a fiber having at least one modified cross-section 20   selected from the group consisting of shapes of an ellipse, crossed circles, a cocoon, a potbelly, a dog bone, a ribbon, three to eight leaves, and a star, the mixing ratio of the fiber having a round cross-section to the fiber having a modified cross-section is preferably 25   8:2 to 1:9, and more preferably 7:3 to 2:8.

The modified cross-section fiber of the present invention as described above preferably has a size of 30

to 80 dtex when used for artificial hair. Further, when
the modified cross-section fiber is blended with human
hair at any ratio, the resulting hair goods can have any
hairstyle freely. If the modified cross-section fiber of
5   the present invention is blended in too high a proportion,
the resulting product is felt hard. If the modified
cross-section fiber is blended in too low a proportion,
the hair goods cannot have any hairstyle freely. For
this reason, it is preferable that 80 to 10 wt% of the
10   modified cross-section fiber be blended with 20 to 80 wt%
of human hair.

The modified cross-section fiber can be blended for
use with another fiber for artificial hair conventionally
used, for example, an acrylonitrile fiber, vinyl chloride
15   fiber, vinylidene chloride fiber, polyester fiber, nylon
fiber, or polyolefin fiber, in addition to the
aforementioned human hair.

The flame retardant polyester composition used in
the present invention can be produced by, for example,
20   dry blending the components (A) and (B) and the optional
component (C) or (D) in advance, and then melt kneading
the components in various common kneading machines.
Examples of the kneading machines include a single-screw
extruder, twin-screw extruder, roll, Banbury mixer, and
25   kneader. Of these, a twin-screw extruder is preferable
in terms of adjustment of the kneading degree and
convenience for operation.

The flame retardant polyester fiber for artificial hair of the present invention can be produced by melt spinning the flame retardant polyester composition by a typical melt spinning process.

5   Specifically, a spun yarn can be obtained by, for example, melt spinning the composition while setting an extruder, gear pump, spinneret, and the like at a temperature of 270 to 310°C; allowing the spun yarn to pass through a heating tube; then cooling the yarn to a

10   glass transition temperature or lower; and taking off the yarn at a rate of 50 to 5,000 m/min. The size of the spun yarn can also be controlled by cooling the yarn in a tank filled with cooling water. The temperature or length of the heat sleeve, the temperature or spraying

15   amount of cooling air, the temperature of the cooling tank, the cooling time, and the take-off rate can be appropriately adjusted according to the discharge amount and the number of holes in the spinneret.

The resulting spun yarn may be hot drawn by either a

20   two-step process comprising winding up the spun yarn once and then drawing the yarn, or a direct spinning and drawing process comprising successively drawing the spun yarn without winding. Hot drawing is carried out by a one-stage drawing process or a multistage drawing process.

25   As heating means in hot drawing, a heat roller, heat plate, steam jet apparatus, hot water tank, or the like

can be used. These can be appropriately used in combination.

The flame retardant polyester fiber for artificial hair of the present invention may contain various
5   additives such as a flame retardant other than the component (B), a heat resistant agent, a photostabilizer, a fluorescent agent, an antioxidant, an antistatic agent, a pigment, a plasticizer, and a lubricant as required. The fiber containing a pigment can be provided as a spun
10   dyed fiber.

When the flame retardant polyester fiber for artificial hair of the present invention thus obtained is a fiber in the form of a non-crimped raw silk, and has a size of usually 30 to 80 dtex, and furthermore 35 to 75
15   dtex, the fiber is suitable for artificial hair. Preferably, the fiber for artificial hair has heat resistance to allow a thermal appliance for beauty (hair iron) to be used therefor at 160 to 200°C, catches fire only with difficulty, and has self-extinguishing
20   properties.

When the flame retardant polyester fiber of the present invention is spun dyed, the fiber can be used as is. When the fiber is not spun dyed, it can be dyed under the same conditions as in a common flame retardant
25   polyester fiber.

The pigment, dye, adjuvant, or the like used for dyeing preferably exhibits excellent weather resistance and flame retardance.

The flame retardant polyester fiber for artificial hair of the present invention exhibits excellent curl setting properties and curl holding properties when a thermal appliance for beauty (hair iron) is used. When the component (C) or (D) is added to the fiber if necessary, the fiber can have a surface with irregularities, can be appropriately matted, and can be more suitably used for artificial hair. Further, the hydrophilic fiber treating agent (E) or an oil agent such as a softening agent can provide the fiber with feeling and texture and make the fiber closer to human hair.

The flame retardant polyester fiber for artificial hair of the present invention may be used in combination with another material for artificial hair such as a modacrylic fiber, polyvinyl chloride fiber, or nylon fiber, or in combination with human hair.

Generally, human hair used in hair products such as wigs, hair wigs, or extensions has cuticle treated, is bleached or dyed, and contains a silicone fiber treating agent or softening agent in order to ensure its feeling and combing properties. Thus, the human hair is flammable, unlike untreated human hair. However, when the human hair is blended with the flame retardant polyester fiber for artificial hair of the present

invention at a human hair blending ratio of 60% or less, the product exhibits excellent flame retardance.

Examples

5   Next, the present invention will be described in more detail with reference to Examples. However, the present invention should not be limited thereto.

Properties values are measured as follows.

(Combing properties)

10   A fiber surface treating agent is attached to a tow filament with a length of 30 cm and a total size of 100,000 dtex. The treated tow filament is combed with a comb (made of Derlin resin) to evaluate ease of combing.

Good: Filament is combed with almost no resistance

15   (light)

Fair: Filament is combed with a little resistance (heavy)

Bad: Filament is combed with a large resistance, or becomes uncombable in the middle

20   (Strength and elongation)

Tensile strength and elongation of a filament are measured using INTESCO Model 201 manufactured by INTESCO Co., Ltd. Both 10 mm-long ends of one 40 mm-long filament are sandwiched in a board (thin paper) to which

25   a two-sided tape pasted with an adhesive is bonded, and are air-dried overnight to prepare a sample with a length of 20 mm. The sample is mounted on a test machine, and a

test is carried out at a temperature of 24°C, at a humidity of 80% or less, at a load of 0.034 cN × size (dtex), and at a tensile rate of 20 mm/min to measure strength and elongation. The test is repeated ten times

5   under the same conditions, and the average values are defined as strength and elongation of the filament.

(Flame retardance)

A filament is cut into filaments with a length of 150 mm each. Filaments with a weight of 0.7 g are

10   bundled, with one end of the bundle sandwiched by a clamp, and the bundle is fixed on a stand and hung vertically. The fixed filaments with an effective length of 120 mm are brought into contact with 20 mm-long fire for 3 seconds, and burned.

15   Flammability

Very good: Afterflame time is 0 second (Filaments do not catch fire)

Good: Afterflame time is less than 3 seconds

Fair: Afterflame time is 3 to 10 seconds

20   Bad: Afterflame time is more than 10 seconds

Drip resistance

Very good: The number of drips until extinguishment is 0

Good: The number of drips until extinguishment is 5

25   or less

Fair: The number of drips until extinguishment is 6 to 10

Bad: The number of drips until extinguishment is 11 or more

(Gloss)

A tow filament with a length of 30 cm and a total size of 100,000 dtex is visually evaluated under sunlight.

Very good: Gloss is adjusted to be the same as in human hair

Good: Gloss is appropriately adjusted

Fair: Gloss is a little too high or a little too low

Bad: Gloss is too high or too low

(Transparence)

A tow filament with a length of 30 cm and a total size of 100,000 dtex is visually evaluated under sunlight.

Good: Transparent and deep-colored (bright)

Fair: A little opaque (cloudy)

Bad: Opaque and not deep-colored

(Devitrification resistance)

A tow filament with a length of 10 cm and a total size of 100,000 dtex is processed with steam (at 120°C and at a relative humidity of 100% for 1 hour), and then sufficiently dried at room temperature. The change in gloss and hue between the tow filament before steam processing and the tow filament after steam processing is examined. As the change is more significant, the tow filament exhibits lower devitrification resistance.

Very good: Neither gloss nor hue is changed

Good: Gloss is not changed, but hue is slightly changed

Fair: Both gloss and hue are slightly changed

Bad: Both gloss and hue are obviously changed

5 (Feeling)

Stickiness

A tow filament with a length of 30 cm and a total size of 100,000 dtex is allowed to stand in a room with constant temperature and humidity (at 23°C and at a

10 relative humidity of 55%) for 3 hours, and then evaluated using a thumb, forefinger, and middle finger on the right hand.

Good: Not sticky

Fair: A little sticky

15 Bad: Sticky

Smooth feeling

A tow filament with a length of 30 cm and a total size of 100,000 dtex is allowed to stand in a thermo-hygrostatic chamber (at 23°C and at a relative humidity

20 of 55%) for 3 hours, and then evaluated using a thumb, forefinger, and middle finger on the right hand.

Very good: Smooth and very slippy

Good: Smooth and slippy

Fair: Not so slippy

25 Bad: Not slippy

(Surface roughness)

Surface roughness was measured using a laser microscope (VK-9500, manufactured by Keyence Corp.). The sides of 10 fibers in parallel with the fiber axes were measured at a magnification of 3,000 (objective lens

5   magnification: 150 × built-in lens magnification: 20) to obtain an image. Surface roughness was calculated from this image based on a calculation formula in accordance with the definition of surface roughness (JIS B0601-1994).
(Iron setting properties)

10 Iron setting properties are an index of the extent to which a hair iron can perform curl setting easily and hold the curl shape. Filaments are loosely sandwiched in a hair iron heated to 180°C, and pre-heated three times by rubbing. Adhesion and combing among the filaments,

15 and frizz and breakage of the filaments are visually evaluated. Next, the pre-heated filaments are wound around the hair iron and held for 10 seconds, and then the iron is withdrawn. The degree of ease of withdrawing the iron (rod out properties) and curl holding properties

20 when withdrawing the iron are visually evaluated.
(Curl setting properties)

Straw-haired filaments are wound around a pipe with a diameter of 32 mm. Curl setting is performed at 110°C for 60 minutes, and aging is performed at room

25 temperature for 60 minutes. Then, one ends of the curled filaments are fixed, and the filaments are hung down to

visually evaluate the degree of ease of curl setting and stability of the curl.

Good: The curl is sufficiently set and is stable

Fair, The curl is set, but is not stable

5   Bad: The curl is not sufficiently set

(Examples 1 to 15)

To a composition made of polyethylene terephthalate dried to have a moisture content of 100 ppm or less, a brominated epoxy flame retardant, organic fine particles, 10 and inorganic fine particles at a composition ratio shown in Tables 1 and 2, 2 parts of a coloring polyester pellet PESM6100 BLACK (manufactured by Dainichiseika Color & Chemicals Mfg. Co., Ltd., carbon black content: 30%, polyester contained in the component (A)) was added, and 15 the components were dry blended. The blend was fed into a twin-screw extruder and melt kneaded at 280°C to form a pellet. Then, the pellet was dried to have a moisture content of 100 ppm or less. Next, the pellet was put into a melt spinning machine, and the molten polymer was 20 spun through a spinneret having round cross-sectional nozzle holes with a nozzle diameter of 0.5 mm each at 280°C, air-cooled, and rolled up at a rate of 100 m/min to obtain a spun yarn. The resulting spun yarn was drawn in a hot water bath at 80°C to prepare a yarn at a draw 25 ratio of 4. The drawn yarn was wound up around a heat roll heated to 200°C at a rate of 30 m/min and heat-treated. Fiber treating agents KWC-Q (ethylene oxide-

propylene oxide random copolymer polyether, manufactured by Marubishi Oil Chemical Co., Ltd.) and KRE-103 (cationic surfactant, manufactured by Matsumoto Yushi-Seiyaku Co., Ltd.) were attached to the yarn in an amount

5   of 0.20 %omf, respectively, to obtain a polyester fiber (multifilament) having a monofilament size of about 50 dtex.

TABLE 1

	Example								
	1	2	3	4	5	6	7	8	9
EFG-85A[*1]	100	100	100	100	100	100	100	100	100
EP-200[*2]	10								
EC-200[*2]		10							
EPC-15[*2]			10	15					
YDB-412[*3]					10	15			
SR-T2000[*4]							15		
SR-T5000[*4]								10	
SR-T7040[*4]									10
U Polymer U-100[*5]			2						
Tipaque CR-60[*6]	0.2	0.2		0.2					
PKP-53[*7]					0.6	0.6	0.6	0.6	0.6

*1: Polyethylene terephthalate, manufactured by Kanebo Gohsen, Ltd.

10   *2: Terminal blocked/terminal non-blocked brominated epoxy flame retardant, manufactured by Dainippon Ink and Chemicals, Inc.

*3: Terminal non-blocked brominated epoxy flame retardant, manufactured by Tohto Kasei Co., Ltd.

*4: Terminal blocked/terminal non-blocked brominated epoxy flame

15   retardant, manufactured by Sakamoto Yakuhin Kogyo Co., Ltd.

*5: Polyallylate, manufactured by Unitika Ltd.

*6: Titanium oxide, manufactured by Ishihara Sangyo Kaisha, Ltd.

*7: Talc, manufactured by Fuji talc Industrial Co., Ltd.

TABLE 2

	Example					
	10	11	12	13	14	15
EFG-85A[*1]	100	100	100	100	100	100
XAC-4965[*9]	15					
SR-T20000[*10]		12	16			
YPB-43M[*11]				5	10	15
U Polymer U-100[*5]		2				
PKP-53[*7]	0.6		0.6			

*1: Polyethylene terephthalate, manufactured by Kanebo Gohsen, Ltd.

*9: Terminal non-blocked brominated epoxy flame retardant, manufactured by Asahi Kasei Corp.

*10: Terminal non-blocked brominated epoxy flame retardant, number average molecular weight: 30,000, manufactured by Sakamoto Yakuhin Kogyo Co., Ltd.

*11: Terminal non-blocked brominated epoxy flame retardant, number average molecular weight: 40,000, manufactured by Tohto Kasei Co., Ltd.

*5: Polyallylate, manufactured by Unitika Ltd.

*7: Talc, manufactured by Fuji talc Industrial Co., Ltd.

Strength and elongation, flame retardance, gloss, transparence, devitrification resistance, combing properties, feeling, surface roughness, iron setting properties, and curl setting properties of the resulting fiber were evaluated. The results are shown in Tables 3 and 4.

TABLE 3

		Comparative Example				
		1	2	3	4	5
Nozzle shape		Round	Round	Round	Round	Round
Size (dtex)		52	48	47	47	50
Amount of fiber treating agents attached (%omf)	KWC-Q	0.2	0.2	0.2	0.2	0.2
	KRE-103	0.2	0.2	0.2	0.2	0.2
Strength (cN/dtex)		2.2	2.0	1.9	2.9	2.6
Elongation (%)		68	63	42	52	47
Flame retardance	Flammability	Fair	Fair	Good	Very good	Very good
	Drip resistance	Bad	Bad	Bad	Very good	Very good
Gloss		Bad	Fair	Fair	Very good	Bad
Transparence		Fair	Fair	Fair	Bad	Fair
Devitrification resistance		Fair	Fair	Bad	Fair	Fair
Combing properties		Bad	Bad	Fair	Fair	Bad
Feeling	Stickiness reduction	Bad	Bad	Bad	Good	Bad
	Smooth feeling	Bad	Bad	Bad	Good	Bad
Surface roughness	Arithmetic mean roughness (μm)	0.1	0.6	0.5	1.2	0.1
	Ten-point mean roughness (μm)	0.1	0.4	0.4	0.5	0.4
Iron setting properties (180°C)	Adhesion	Good	Good	Good	Good	Good
	Crimping/end breakage	Good	Good	Good	Good	Good
	Rod out	Good	Good	Good	Good	Good
	Holding properties	Good	Good	Good	Good	Good
Curl setting properties (110°C)		Good	Good	Good	Good	Good

TABLE 4

		Comparative Example				
		1	2	3	4	5
Nozzle shape		Round	Round	Round	Round	Round
Size (dtex)		52	48	47	47	50
Amount of fiber treating agents attached (%omf)	KWC-Q	0.2	0.2	0.2	0.2	0.2
	KRE-103	0.2	0.2	0.2	0.2	0.2
Strength (cN/dtex)		2.2	2.0	1.9	2.9	2.6
Elongation (%)		68	63	42	52	47
Flame retardance	Flammability	Fair	Fair	Good	Very good	Very good
	Drip resistance	Bad	Bad	Bad	Very good	Very good
Gloss		Bad	Fair	Fair	Very good	Bad
Transparence		Fair	Fair	Fair	Bad	Fair
Devitrification resistance		Fair	Fair	Bad	Fair	Fair
Combing properties		Bad	Bad	Fair	Fair	Bad
Feeling	Stickiness reduction	Bad	Bad	Bad	Good	Bad
	Smooth feeling	Bad	Bad	Bad	Good	Bad
Surface roughness	Arithmetic mean roughness (μm)	0.1	0.6	0.5	1.2	0.1
	Ten-point mean roughness (μm)	0.1	0.4	0.4	0.5	0.4
Iron setting properties (180°C)	Adhesion	Good	Good	Good	Good	Good
	Crimping/end breakage	Good	Good	Good	Good	Good
	Rod out	Good	Good	Good	Good	Good
	Holding properties	Good	Good	Good	Good	Good
Curl setting properties (110°C)		Good	Good	Good	Good	Good

(Comparative Examples 1 to 5)

To a composition made of polyethylene terephthalate
dried to have a moisture content of 100 ppm or less, a
brominated epoxy flame retardant, and inorganic fine
particles at a composition ratio shown in Table 5, 2

parts of a coloring polyester pellet PESM6100 BLACK (manufactured by Dainichiseika Color & Chemicals Mfg. Co., Ltd., carbon black content: 30%, polyester contained in the component (A)) was added, and the components were dry

5   blended. The blend was fed into a twin-screw extruder and melt kneaded at 280°C to form a pellet. Then, the pellet was dried to have a moisture content of 100 ppm or less. Next, the pellet was put into a melt spinning machine, and the molten polymer was discharged from a

10 spinneret having round cross-sectional nozzle holes with a nozzle diameter of 0.5 mm each at 280°C, air-cooled, and wound up at a rate of 100 m/min to obtain a spun yarn. The resulting spun yarn was drawn in a hot water bath at 80°C to prepare a yarn at a draw ratio of 4. The drawn

15 yarn was wound up around a heat roll heated to 200°C at a rate of 30 m/min and heat-treated. Fiber treating agents KWC-Q (ethylene oxide-propylene oxide random copolymer polyether, manufactured by Marubishi Oil Chemical Co., Ltd.) and KRE-103 (cationic surfactant, manufactured by

20 Matsumoto Yushi-Seiyaku Co., Ltd.) were attached to the yarn in an amount of 0.20 %omf, respectively, to obtain a polyester fiber (multifilament) having a monofilament size of about 50 dtex.

Strength and elongation, flame retardance, gloss,
25 transparence, devitrification resistance, combing properties, feeling, surface roughness, iron setting

properties, and curl setting properties of the resulting fiber were evaluated. The results are shown in Table 6.

TABLE 5

	Comparative Example				
	1	2	3	4	5
EFG-85A[*1]	100	100		100	100
Triphenyl phosphate	10				
PX-200[*12]		10			
Heim RH-416[*13]			100		
Pyrochek 68PB[*14]				6	
FR-1808[*15]					10
Tipaque CR-60[*6]		1			

*1: Polyethylene terephthalate, manufactured by Kanebo Gohsen, Ltd.

5   *12: Condensed phosphate flame retardant, manufactured by Daihachi Chemical Industry Co., Ltd.

*13: Phosphorus flame retardant copolymer polyester, manufactured by Toyobo Co., Ltd.

*14: Brominated polystyrene flame retardant, manufactured by Nissan

10   Ferro Organic Chemical Co., Ltd.

*15: Octabromotrimethylphenylindane, manufactured by Bromokem Far East Ltd.

*6: Titanium oxide, manufactured by Ishihara Sangyo Kaisha, Ltd.

TABLE 6

		Comparative Example				
		1	2	3	4	5
Nozzle shape		Round	Round	Round	Round	Round
Size (dtex)		52	48	47	47	50
Amount of fiber treating agents attached (%omf)	KWC-Q	0.2	0.2	0.2	0.2	0.2
	KRE-103	0.2	0.2	0.2	0.2	0.2
Strength (cN/dtex)		2.2	2.0	1.9	2.9	2.6
Elongation (%)		68	63	42	52	47
Flame retardance	Flammability	Fair	Fair	Good	Very good	Very good
	Drip resistance	Bad	Bad	Bad	Very good	Very good
Gloss		Bad	Fair	Fair	Very good	Bad
Transparence		Fair	fair	Fair	Bad	Fair
Devitrification resistance		Fair	Fair	Bad	Fair	Fair
Combing properties		Bad	Bad	Fair	Fair	Bad
Feeling	Stickiness reduction	Bad	Bad	Bad	Good	Bad
	Smooth feeling	Bad	Bad	Bad	Good	Bad
Surface roughness	Arithmetic mean roughness (μm)	0.1	0.6	0.5	1.2	0.1
	Ten-point mean roughness (μm)	0.1	0.4	0.4	0.5	0.4
Iron setting properties (180°C)	Adhesion	Good	Good	Good	Good	Good
	Crimping/end breakage	Good	Good	Good	Good	Good
	Rod out	Good	Good	Good	Good	Good
	Holding properties	Good	Good	Good	Good	Good
Curl setting properties (110°C)		Good	Good	Good	Good	Good

As shown in Tables 3 and 4, it was confirmed that the fibers of Examples are superior to the fibers of

5   Comparative Examples in terms of flame retardance, gloss, transparence, devitrification resistance, combing properties, feeling, iron setting properties, and curl

setting properties. Accordingly, it was confirmed that the fiber for artificial hair of interest using a brominated epoxy flame retardant can be effectively used as artificial hair with improved flame retardance, gloss,

5   transparence, setting properties, devitrification resistance, and combing properties, while maintaining mechanical properties and thermal properties possessed by polyester.

(Examples 16 to 22)

10   To a composition made of polyethylene terephthalate dried to have a moisture content of 100 ppm or less, a brominated epoxy flame retardant, and inorganic fine particles at a composition ratio shown in Table 7, 2 parts of a coloring polyester pellet PESM6100 BLACK

15   (manufactured by Dainichiseika Color & Chemicals Mfg. Co., Ltd., carbon black content: 30%, polyester contained in the component (A)) was added, and the components were dry blended. The blend was fed into a twin-screw extruder and melt kneaded at 280°C to form a pellet. Then, the

20   pellet was dried to have a moisture content of 100 ppm or less. Next, the pellet was put into a melt spinning machine, and the molten polymer was discharged from a spinneret having nozzle holes with a cross-section of Figures 8 to 10 at 280°C, air-cooled, and wound up at a

25   rate of 100 m/min to obtain a spun yarn. The resulting spun yarn was drawn in a hot water bath at 80°C to prepare a yarn at a draw ratio of 4. The drawn yarn was

wound up around a heat roll heated to 200°C at a rate of 30 m/min and heat-treated. Fiber treating agents KWC-Q (ethylene oxide-propylene oxide random copolymer polyether, manufactured by Marubishi Oil Chemical Co.,

5   Ltd.) and KRE-103 (cationic surfactant, manufactured by Matsumoto Yushi-Seiyaku Co., Ltd.) were attached to the yarn in an amount of 0.20 %omf, respectively, to obtain a polyester fiber (multifilament) having a monofilament size of about 60 to 70 dtex.

10 TABLE 7

	Example						
	16	17	18	19	20	21	22
EFG-85A[*1]	100	100	100	100	100	100	100
SR-T20000[*10]	10	10	10	10	10		
YPB-43M[*11]						15	15
PKP-53[*7]	0.5	0.5	0.5	0.5	0.5		
Imsil A-8[*16]	0.5	0.5	0.5	0.5	0.5		

*1: Polyethylene terephthalate, manufactured by Kanebo Gohsen, Ltd.

*10: Terminal non-blocked brominated epoxy flame retardant, number average molecular weight: 30,000, manufactured by Sakamoto Yakuhin Kogyo Co., Ltd.

15 *11: Terminal non-blocked brominated epoxy flame retardant, number average molecular weight: 40,000, manufactured by Tohto Kasei Co., Ltd.

*7: Talc, manufactured by Fuji talc Industrial Co., Ltd.

*16: Silica, manufactured by Unimin Corp.

20 (In Figure 8, A is 0.9 mm, and B is 0.4 mm.)

(In Figure 9, A is 1.0 mm, B is 0.35 mm, and C is 0.25 mm.)

(In Figure 10, R is 0.6 mm, and r is 0.4 mm.)

Strength and elongation, flame retardance, gloss, transparence, devitrification resistance, combing properties, feeling, surface roughness, iron setting properties, and curl setting properties of the resulting fiber were evaluated. The results are shown in Table 8.

TABLE 8

		Example						
		16	17	18	19	20	21	22
Nozzle shape		Modified 1	Modified 2	Modified 3	Modified 1/Round =67/33	Modified 1/Round =50/50	Modified 1	Modified 2
Size (dtex)		67	65	68	62	59	70	68
Amount of fiber treating agents attached (%omf)	KWC-Q	0.2	0.2	0.2	0.2	0.2	0.2	0.2
	KRE-103	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Strength (cN/dtex)		2.5	2.2	1.8	2.7	2.9	2.4	2.2
Elongation (%)		68	53	38	59	52	53	48
Flame retardance	Flamma-bility	Very good	Very good	Very good	Very good	Very good	Very good	Very good
	Drip resistance	Very good	Very good	Very good	Very good	Very good	Very good	Very good
Gloss		Good	Good	Good	Good	Good	Very good	Very good
Transparence		Good	Good	Good	Good	Good	Good	Good
Devitrification resistance		Good	Good	Good	Good	Good	Good	Good
Combing properties		Good	Good	Good	Good	Good	Good	Good
Feeling	Stickiness reduction	Good	Good	Good	Good	Good	Good	Good
	Smooth feeling	Very good	Very good	Very good	Very good	Very good	Very good	Very good
Surface roughness	Arithmetic mean roughness (μm)	1.0	1.0	1.1	1.0	1.1	1.4	1.3
	Ten-point surface roughness (μm)	0.8	0.9	0.8	0.7	0.8	1.1	1.1
Iron setting properties (180°C)	Adhesion	Good	Good	Good	Good	Good	Good	Good
	Crimping/ end breakage	Good	Good	Good	Good	Good	Good	Good
	Rod out	Good	Good	Good	Good	Good	Good	Good
	Holding properties	Good	Good	Good	Good	Good	Good	Good
Curl setting properties (110°C)		Good	Good	Good	Good	Good	Good	Good

(Examples 23 to 29)

　　　To a composition made of polyethylene terephthalate dried to have a moisture content of 100 ppm or less, a brominated epoxy flame retardant, and inorganic fine

5　　particles at a composition ratio shown in Table 9, 2 parts of a coloring polyester pellet PESM6100 BLACK (manufactured by Dainichiseika Color & Chemicals Mfg. Co., Ltd., carbon black content: 30%, polyester contained in the component (A)) was added, and the components were dry

10　　blended. The blend was fed into a twin-screw extruder and melt kneaded at 280°C to form a pellet. Then, the pellet was dried to have a moisture content of 100 ppm or less. Next, the pellet was put into a melt spinning machine, and the molten polymer was spun through a

15　　spinneret having nozzle holes with a cross-section of Figures 8 and 9 at 280°C, air-cooled, and rolled up at a rate of 100 m/min to obtain a spun yarn. The resulting spun yarn was drawn in a hot water bath at 80°C to prepare a yarn at a draw ratio of 4. The drawn yarn was

20　　rolled up around a heat roll heated to 200°C at a rate of 30 m/min and heat-treated. Fiber treating agents shown in Table 10 were respectively attached to the yarn to obtain a polyester fiber (multifilament) having a monofilament size of about 70 dtex.

TABLE 9

	Example						
	23	24	25	26	27	28	29
EFG-85A[*1]	100	100	100	100	100	100	100
SR-T20000[*10]	16	16	16	16	16		
YPB-43M[*11]						15	15
PKP-53[*7]	0.6	0.6	0.6	0.6	0.6		

*1: Polyethylene terephthalate, manufactured by Kanebo Gohsen, Ltd.

*10: Terminal non-blocked brominated epoxy flame retardant, number average molecular weight: 30,000, manufactured by Sakamoto Yakuhin Kogyo Co., Ltd.

*11: Terminal non-blocked brominated epoxy flame retardant, number average molecular weight: 40,000, manufactured by Tohto Kasei Co., Ltd.

*7: Talc, manufactured by Fuji talc Industrial Co., Ltd.

TABLE 10

		Example						
		23	24	25	26	27	28	29
Nozzle shape		Modified 1	Modified 1	Modified 1	Modified 1	Modified 1	Modified 2	Modified 2
Size (dtex)		70	70	70	70	70	68	68
Amount of fiber treating agents attached (%omf)	KWC-Q[17]	0.1	0.25	0.15			0.1	
	KRE-103[18]	0.1					0.1	
	KRE-102[19]		0.2	0.1				
	KRE-15[20]				0.2	0.1		0.1
	KRE-16[21]				0.14	0.07		0.07
	KRE-17[22]				0.06	0.03		0.03
Strength (cN/dtex)		2.5	2.5	2.5	2.5	2.5	2.4	2.4
Elongation (%)		54	54	54	54	54	48	48
Flame retardance	Flammability	Very good	Very good	Very good	Very good	Very good	Very good	Very good
	Drip resistance	Very good	Very good	Very good	Very good	Very good	Very good	Very good
Gloss		Good	Good	Good	Good	Good	Very good	Very good
Transparence		Good	Good	Good	Good	Good	Good	Good
Devitrification resistance		Good	Good	Good	Good	Good	Good	Good
Combing properties		Good	Good	Good	Good	Good	Good	Good
Feeling	Stickiness reduction	Good	Good	Good	Good	Good	Good	Good
	Smooth feeling	Good	Very good	Good	Very good	Good	Good	Good
Surface roughness	Arithmetic surface roughness (μm)	1.0	1.0	1.0	1.0	1.0	1.4	1.4
	Ten-point surface roughness (μm)	0.8	0.8	0.8	0.8	0.8	1.1	1.1
Iron setting properties (180°C)	Adhesion	Good	Good	Good	Good	Good	Good	Good
	Crimping/ end breakage	Good	Goo-d	Good	Good	Good	Good	Good
	Rod out	Good	Good	Good	Good	Good	Good	Good
	Holding properties	Good	Good	Good	Good	Good	Good	Good
Curl setting properties (110°C)		Good	Good	Good	Good	Good	Good	Good

As shown in Tables 8 and 10, it was confirmed that a fiber for artificial hair having excellent properties and quality balance can be obtained by modifying the fiber cross-section or using a specific fiber treating agent.

Industrial Applicability

An object of the present invention is to provide a flame retardant polyester fiber for artificial hair in

which problems of the prior art are solved and which

maintains fiber properties such as heat resistance and

strength and elongation possessed by a common polyester

fiber, has excellent flame retardance, setting properties,

5   drip resistance, transparence, devitrification resistance,

stickiness reduction, and combing properties required for

artificial hair, and has fiber luster controlled

according to need.

Another object of the present invention is to

10   provide a polyester fiber for artificial hair which

maintains fiber properties such as heat resistance and

strength and elongation possessed by a polyester fiber,

improves defective curling properties of such a polyester

fiber, and has excellent luster, feeling, and combing

15   properties by using the above-described polyester fiber

for artificial hair which has at least one modified

cross-section, is a mixture with a fiber having a

modified cross-section, and has a mixing ratio of the

fiber having a round cross-section to the fiber having a

20   modified cross-section is 8:2 to 1:9.

The present invention further provides a flame

retardant fiber for artificial hair which does not have

reduced flame retardance as in the case where such a

fiber is treated with a silicone fiber treating agent in

25   order to improve smooth feeling and texture, for example;

has slip feeling and combing properties the same as in

the case where such a fiber is treated with a silicone

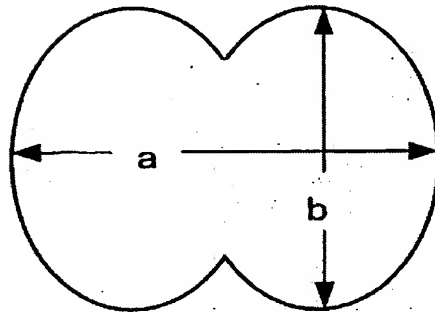oil agent for the same purpose; and has excellent flame retardance.
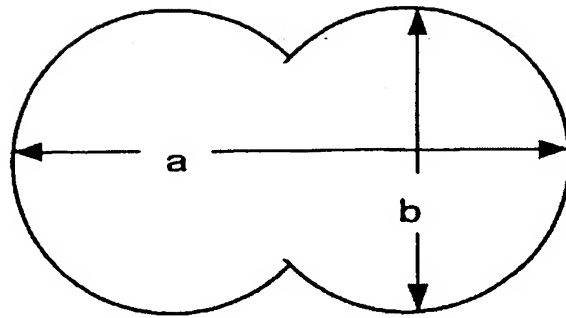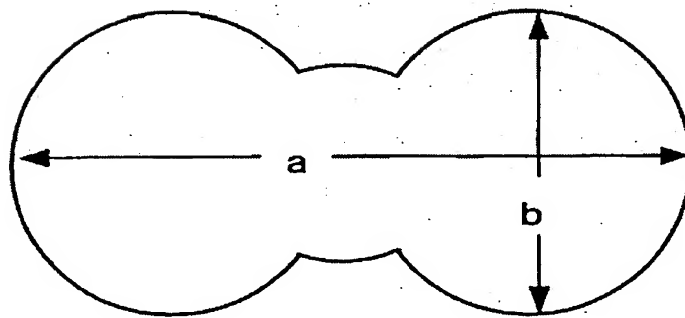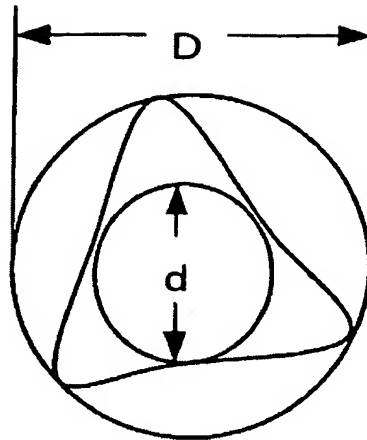
FIG.1

FIG.2

FIG.3

FIG.4

FIG.5
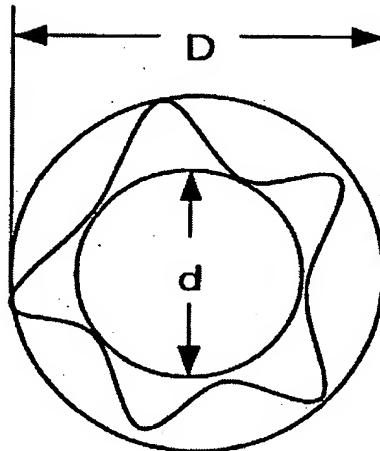
FIG.6

FIG.7

FIG.8

FIG.9

FIG.10

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10